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SOME DIETARY ITEMS OF OUTER-URBAN GREY BUTCHERBIRDS IN THE PERTH HILLS

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ABSTRACT

The diet of Grey Butcherbirds in an outer-urban environment was examined by analysing the prey items of pellets (n = 36) regurgitated by known birds frequenting an artificial feeding station in the Perth Hills. Regardless of season, beetles (Coleoptera) were by far the most important prey category in both adult and juvenile butcherbirds followed by lizards in adult birds, and earwigs (Dermaptera) in juvenile butcherbirds. Seeds were found in 28% of the pellets (10/36) and occasionally in considerable numbers. Although food availability was not measured, these butcherbirds seem to be harvesting most key prey categories more or less relative to their availability as the seasonal fluctuations seen in their diet broadly followed the expected seasonal abundances of the key prey categories.

INTRODUCTION

The Grey Butcherbird (*Cracticus torquatus*) is a widely distributed species endemic to Australia. It occurs in a range of different habitats including arid, semi-arid, and temperate zones (Chapman *et al.* 1986). However, although its prey can include small mammals, birds, eggs, reptiles and insects, detailed information on the diet of this species is rather scanty (Barker and Vestjens 1989; Legge 1931), particularly for urban and outer-urban environments. This paper examines the latter by assessing the diet of free-ranging outer-urban butcherbirds using the prey items identified in the regurgitated pellets of known birds. An Index of Relative Importance (IRI) was calculated to assess the relative importance of each dietary category to these birds.

METHODS

Origin of Regurgitated Pellets

The pellets were collected from known butcherbirds frequenting an artificial feeding station at Lesmurdie on the Darling Scarp, Perth, Western Australia (32° 0'30.56"S; 116° 2'15.47"E). The breeding adult female first arrived as a sub-adult late in 2005, and then with an adult male in early 2006. She subsequently brought two offspring in each of the following two years. Thus the pellets were collected over approximately 2.5 years (2005–2007), with the birds being regular visitors over this period. Individual birds (*n* = 6) could be easily identified by their physical characteristics, and their behavioural traits. The butcherbirds ultimately stopped their visitation due to continued harassment by Red Wattlebirds (*Anthochaera carunculata*). Only those pellets that could be clearly assigned as belonging to a butcherbird were collected. There were 36 pellets in total: 15 from the adult female, 11 from the same offspring when adult, 4 from known juvenile birds, and 6 whose owner could not be ascertained (left while two birds were feeding). Of the latter, and based on the size and contents of the pellets, 5 unknowns were considered to be from adult birds and the remaining pellet from a juvenile.

Pellet Processing

The pellets were kept frozen (–12 °C) in individually labelled vials until analysed. Individually thawed pellets were placed in a Petri dish containing a 50% (v/v) aqueous ethanol solution, and the items sorted into each food category using a dissecting microscope. The area occupied by each food category relative to the area of all items in a pellet was then determined. This measure becomes 'A' in the Index of Relative Importance (see below). A whiteboard card with a 10 x 10 grid of 6 mm squares was used when estimating 'A'. The pellet contents were identified as specifically as possible using: the Insects of Australia manual (CSIRO 1973), the Pest and Disease Image Library located at http://www.padil.gov.au/ (November 2011), Google Images at http://www.google.com.au/imghp?hl=en&tab=wi (November 2011), reference specimens collected at the study site, and the valued experience of several colleagues (see Acknowledgements).

Index of Relative Importance (IRI) and Dietary Breadth

The Index of Relative Importance (IRI) was first used in dietary studies of fishes (Pinkas 1971). It is usually determined for each prey category as follows:

$$IRI = (N + V) * F$$

where N = the numerical percentage (i.e. the numbers of a particular prey item as a percentage of the total number of all items in that sample), V = the volumetric percentage (i.e. the volume of an item as a percentage of the total sample volume), and F = frequency of occurrence percentage (i.e. the number of stomachs containing a particular food category), although the percentage volume as been replaced with the weight (biomass) percentage (W) in some studies (e.g. Martin *et al.* 1996; Twigg *et al.* 1996). However, with the butcherbird study, and mainly because of fragmentation, it was not possible to realistically count or weigh the individual items so the area covered by each food category ('A') was measured as the percentage area relative to the total area occupied by all items in each pellet.

Consequently, a modified IRI was used:

$$IRI = A * F$$

'A' was calculated for each individual pellet and the mean value for each category was then used to determine the IRI. Adult birds were treated separately from juvenile birds, and the unidentified category was excluded from the analysis. This modified IRI is similar to that used for turtle (*Elseya* sp.) diet by Armstrong and Booth (2005), except that they used 'V' and 'F' only. The IRI allows a relative comparison of the importance of each food category, but it does not take into account any differences in the calorific and nutritional value of individual food items.

Dietary (niche) Breadth (D_B) was calculated according to Pianka and Pianka (1976). Dietary breadth is based upon the diversity index of Simpson (1949) and was calculated as

$$D_B = 1/\sum_{i}^{n} pi^2 * 1/n$$

where *pi* is the proportion of the *ith* resource category used. When divided by the number of resource categories used (*n*) this index varies from near zero (1/n - a narrow dietary range) to a maximum of one (a wide range of dietary items).

RESULTS

Beetles (Coleoptera) were the main food items of both adult and juvenile birds (Tables 1 and 2). Lizards, and earwigs (Dermaptera) were next most populous food items but no lizard remains were identified in the pellets from the juvenile birds. For adults, the presence of beetles in the pellets ranged from 4%–98% by percentage area (Mean 66.0%, SD 26.8%, *n* = 31) with all pellets containing some

Table 1. The 12 food categories identified in the regurgitated pellets (*n* = 31), and their relative importance to adult outer-urban Grey Butcherbirds.

Food Category	Maximum Food Item Area (%) [A]	Mean Food Item Area (%) [B]	% of Pellets	IRI	IRI Rank
Coleoptera	98	66.0	100.0	6599.7	1
Lizard	45	7.7	58.1	443.9	2
Dermaptera	96	8.9	41.9	372.0	3
Seed	40	3.2	25.8	82.8	4
Heteroptera – Nysius bug	53	4.8	12.9	61.4	5
Araneae	20	1.4	32.3	44.2	6
Hymenoptera – Ants	15	0.8	45.2	34.4	7
Blattodea	26	1.7	16.1	27.8	8
Hymenoptera – Bees & Wasps	21	1.3	19.4	24.7	9
Orthoptera & Mantodea	5	0.3	19.4	6.0	10
Diplopoda	10	0.4	12.9	4.8	11
Bird Bone	43	1.4	3.2	4.5	12

A: All minium percentage areas were zero (0) except for Coleoptera which was 4%.
B: Used to calculate the IRI.

Table 2. The food categories identified in the regurgitated pellets (*n* = 5) of juvenile outer-urban Grey Butcherbirds. Less than 1% of items could not be classified, and no other food categories were seen.

	Coleoptera	Dermaptera	Blattodea	Seed
Mean area (%)	64.0	9.8	8.4	17.2
# Pellets with food category	4	2	1	2

beetle remains. Beetle remains in juvenile butcherbirds ranged from 0% to 100% of the contents (Mean 64.0%, SD 41.7%, *n* = 5). The juvenile pellet with no recorded beetle contained only seed (77%) and earwig remains (23%). Seeds were the fourth most populous food item occurring in 28% of pellets (i.e. 10/36 – Tables 1 and 2), with 143 seeds and three identifiable seed types in the 10 pellets (Table 3).

Some of the insects more precisely identified from the pellets included: Order Coleoptera: flower chafer beetles (Scarabaeidae, Subfamily Cetoniinae); rhinoceros beetles (Scarabaeidae, Subfamily Dynastinae); green scarab beetle (Scarabaeidae, *Diphucephala* sp.); jewel beetles (Buprestidae); longicorn beetles (Cerambycidae); and weevils (Curculionoidea); Order Hemiptera: *Nysius* sp. (Suborder Heteroptera, Lygaeidae, Subfamily Orsillinae – most likely the Rutherglen Bug, *Nysius*

Table 3. Measurements (mm) of some seeds and lizard bones recovered from the butcherbird pellets.

			Dimensions (mm)			
			Length		Width	
Category	Description	*n*	Mean	SD	Mean	SD
PLANT						
Seed Type 1	Creamy, ovoid, Dicot[A]	12	1.71	0.17	1.36	0.11
Seed Type 2	Brown, kidney-shaped, hard, Dicot, Legume[B]	19	5.63	0.78	4.29	0.65
Fruit	Ericaceae[C] – Creamy, ovoid, very hard, nut-like	1	5.00	–	2.75	–
					Min	Max
LIZARD	Jaw	8	4.88	0.82	3.50	6.00
	Leg Bone	8	5.18	1.75	3.00	6.75
	Rib	3	3.17	0.14	3.00	3.25
	Vertebrae	12	1.78	0.47	1.00	2.75

A: Identified by the presence of endosperm and two cotyledons in dissected seed.

B: Identified by the characteristic shape, and the presence of endosperm and two cotyledons in dissected seed. Possibly *Podalyria* sp. (?).

C: Australian heaths (Epacrids), identified by the Western Australian Herbarium.

vinitor); Order Hymenoptera: Formicidae: *Pheidole* ant queens (*Pheidole* sp.); bulldog ants (*Myrmecia* sp.); *Camponotus* sp. ants; Apidae: European honey bees (*Apis mellifera*); Hymenoptera: wasps; Order Mantodea: mantids. Likely identifications included: shield bugs (Hemiptera, Suborder Heteroptera, Superfamily Pentatomoidea, possibly *Poecilometis* sp.). Of the above, only *Nysius* sp. and European Honey Bees were known to comprise introduced species suggesting that butcherbirds eat a range of indigenous invertebrates.

In general, adult butcherbirds had a fairly narrow range of food items with only 12 categories identified from the pellets over the 2.5 year study with the top five ranked categories making up 90.5% of all items by percentage area (Table 1) (excludes the unidentified category – see below). This was further illustrated by the low Dietary Breadth index of 0.1842 (near zero values indicate a narrow dietary range). The diet of juvenile birds seemed even narrower than that of adults and included only four identifiable food categories (Table 2). The importance of beetles to adult birds seemed greatest in winter (Figure 1) when, perhaps, the range of available food items is more limited. The reliance on

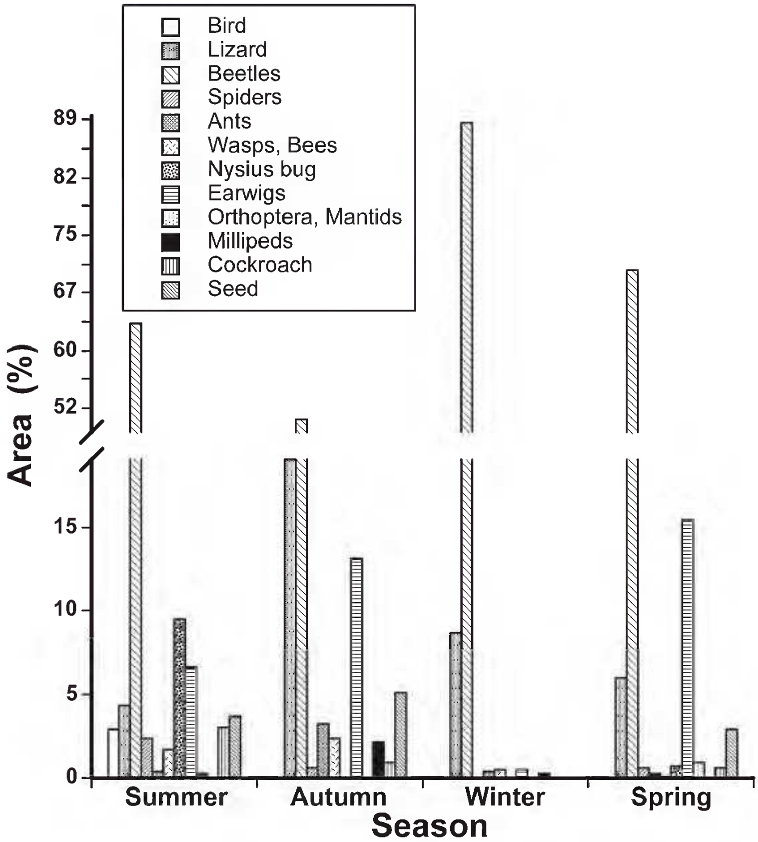

Figure 1. Seasonal changes in the food items consumed by outer-urban adult Grey Butcherbirds based on the analysis of regurgitated pellets (n = 31) collected at Lesmurdie, WA. n = 15, 5, 4, and 7 pellets for each season respectively. ' % Area' is the percentage area of a given category relative to the area occupied by all categories for the pellets (see Methods).

beetles as food appeared least in autumn, and this corresponded with the greatest occurrence of lizard remains. Nevertheless, lizard remains were found across all seasons for adult birds (Figure 1).

The remains of lizards were identified by the presence of complete jaw bones, 'scales', and obvious skin (with some colouration retained in some instances). These bones were also quite small and delicate ranging from 1.0 mm (vertebrae) to 6.8 mm (leg bone) in length (Table 3). Although bird bone (most likely from a young immature individual) was found in one adult pellet, no feathers or hair were recovered from any pellet. Ants had been clearly ingested by the butcherbirds as these remains were usually comprised of incomplete heads, and occasionally, incomplete bodies, imbedded within the pellets. The importance of ants may have therefore been underestimated in the diet because of their limited recovery. Seeds also appeared to have been deliberately ingested by some butcherbirds as 95 seeds of Seed Type 1 (Table 3) were found in a single pellet from the adult female. These seeds, which were ovoid in shape, were quite small (Table 3) with 123 of these seeds recovered from two pellets from the adult female. A total of 19 relatively large, kidney-shaped, legume seeds (5.6 x 4.3 mm; Seed Type 2 – Table 3) were also recovered from three pellets from two different birds (1 adult –2 pellets, 1 juvenile pellet). Seeds also included a fruit of an unknown Epacrid (Ericaceae – Table 3).

The percentage area of those fragments/items which could not be classified ranged from 0% to 8% for adult butcherbirds (Mean 2.35% ± 2.26% SD, n = 31), and 0% to 1% for the juvenile birds (Mean 0.60% ± 0.55% SD, n = 5). Very small amounts of plant vegetative fragments were found in three pellets, three young conifer buds (growing tips) in one adult pellet, small quartz grains (1–3 mm) in four pellets, and what appeared to be insect egg cases (n = 15) in one pellet. All these items were included in the unidentifiable category, and therefore excluded from the IRI.

The 'species accumulation curve' showing the effect of increasing the number of pellets examined on the cumulative number of identifiable food categories (Figure 2) indicated that the number of pellets used in this study was adequate to gain an understanding of the diet of outer-urban Grey Butcher birds. Eighty-three percent of the food categories could be found using just 6 pellets (Figure 2).

DISCUSSION

The reliance of outer-urban Grey Butcherbirds on beetles (Coleoptera) as their primary prey item is consistent with that reported elsewhere for this, and closely related (e.g. Pied Butcherbird *C. nigrogularis*), species (Chapman *et al.* 1986; Barker and Vestjens 1989). For adult birds, lizard remains comprised the second most important prey item in the pellets. Moreover, based on the measurements of recovered bone (Table 3), the lizards consumed were quite small and were probably skinks. This food category was most abundant in autumn, which corresponds with the season when most juvenile skinks hatch in urban areas in Perth (Ric How, personal communication). Grey Butcherbirds are also known to capture and skewer live skinks (e.g. *Ctenotus regius*) in the wild (Fitzsimons and Thomas 2010). The absence of lizard remains from the outer-

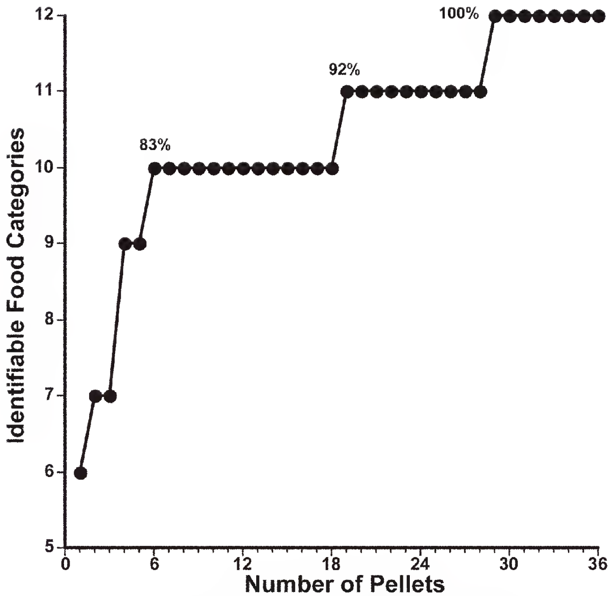

Figure 2. 'Species accumulation curve' showing the effect of the number of pellets examined on the cumulative number of identifiable food categories in the butcherbird pellets. Eighty-three percent of the food categories were identified in just 6 pellets.

urban juvenile butcherbird pellets suggests that young birds may be less astute than older birds at catching such prey. However, the Grey Butcherbird observed by Fitzsimons and Thomas (2010) was classified as 'immature' indicating that these birds can catch small skinks on occasion, at least in semi-arid environments.

Seeds and fruit have been reported in the diet of Grey Butcherbirds (Chapman *et al.* 1986; Barker and Vestjens 1989), and the Collared Butcherbird (*C. destructor*) is known to consume ripe figs (Chandler 1915). Grey Butcherbirds have also been observed feeding on the flesh of *Macrozamia* fruit (Stranger and Stranger 1970). The sheer number of seeds found in the pellets of the outer-urban Grey Butcherbirds suggests that they were deliberately ingested. However, whether they were gathered as seeds or eaten with a fruit is unknown. The inclusion of the kidney-shaped legume seed is interesting because it superficially resembled some of the beetle remains found in the pellets. Some birds may have therefore mistaken these seeds for beetles, although this is only speculative. The recovered legume seeds, which had a very hard testa, seemed entirely intact (germination tests could not be done as the samples had been frozen). The inclusion of the small conifer buds in one adult pellet most likely resulted from accidental ingestion while catching arboreal prey.

Although no feathers were found, there appeared to be bone remains of a young (nestling?) bird in one pellet of an adult butcherbird. Again, this is consistent with what is known about the diet these birds. Small birds, eggs, and nestlings can be consumed by Grey, and other, butcherbirds (Chapman *et al.* 1986; Barker and Vestjens 1989); Higgins *et al.* 2006), and this includes House Sparrows *Passer domesticus* (Legge 1931).

Although my outer-urban study is the first I know of that tracks individual birds for over two years, and which includes both adult and juvenile birds, some caveats still need to be considered.

While the number of pellets examined was adequate to gain a broad understanding of the diet of outer-urban butcherbirds (see Figure 2), they were nevertheless collected from only 4–6 individual birds. There were also only 5 pellets from known juvenile birds. However, the available literature, and the 'species accumulation curve' (Figure 2), suggests that this outer-urban study does, nevertheless, reflect the diet of Grey Butcherbirds in this environment.

Some prey categories (e.g. ants, spiders) may have been underestimated in the diet because little of their exoskeletons remained in the pellets. That is, the importance of each food category was based solely upon the area that it occupied as a percentage of all the items found in a pellet.

As mentioned previously, although the IRI approach enables a comparison of the relative importance of individual prey items, it does not take into account the differences in the calorific and nutritional value of the food items consumed. For example, at times, the benefit-cost of catching and consuming small skinks may be more favourable than feeding on ants. Similarly, beetles are probably the most abundant available food, and therefore may require less effort to find and consume (i.e. equals the best optimal foraging strategy).

I had no measure of prey/food availability in the associated outer-urban environment and therefore it is not possible to make definitive conclusions on whether outer-urban butcherbirds were preferentially targeting some prey (but see below), or whether they were simply harvesting them according to their relative availability in the environment.

Despite the above caveats, however, this study suggests that beetles are the most important prey category for outer-urban Grey Butcherbirds, and that few mammals and birds appear to be consumed (based on the lack of hair and feathers in the pellets). These butcherbirds also seem to be harvesting most of their prey more or less relative to their availability, as the seasonal fluctuations seen in their diet broadly follow the expected seasonal abundances of the key prey categories. However, further detailed study would be required to confirm this. It also appears that the diet of outer-urban Grey Butcherbirds may be similar to that seen for more urban individuals of this species, although the available data for the later is rather limited (Claire Stevenson personal communication).

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